



# Effect of Diaphragm Strengthening Exercise with Incentive Spirometry on Pain and Core Muscle Stability in Low Back Pain Patients at M.Yunus Hospital Bengkulu

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## Abstract:

This study examined the effect of diaphragm strengthening exercise with incentive spirometry on pain and core muscle stability in patient with LBP (Low Back Pain). Twenty respondents aged 25-60 years participated in this research group. This research using a pre-experimental one-group pretest-posttest design. Incentive spirometry training was given to one group 3 times a week for 4 weeks. Pain level was measured using the numerical rating scale and core muscle stability was measured using a sphygmomanometer which had been modified to function as a tool to measure core muscle stability. There was a decrease in pain levels and an increase in core muscle stability in research subjects. The results of the wilcoxon test and paired t-test obtained a significance value of less than 0.05. There is an effect of diaphragm muscle strengthening exercises using incentive spirometry on improving pain and core muscle stability in patients with LBP (Low Back Pain).

**Keywords:** Core Muscles, Incentive Spirometry, Low Back Pain

## 1. INTRODUCTION

Low back pain (LBP) is experienced by 90% of adults at least once in their lifetime which affect daily activities and cause psychological, economic and social burdens (Kang et al., 2020). The prevalent numbers of people with LBP increased with age, and peaked around the ages of 80 to 89 years, and higher in females than males (Wu et al., 2020). On the otherside, LBP is quite common among middle-aged adults in Indonesia with potential risk factors are female gender, higher body mass index, lack of physical activity, stress level, and years of work experience (Makkiyah et al., 2023). Pre-research data observed at the Medical Rehabilitation Installation in M. Yunus Hospital Bengkulu Province revealed that around 60% of patients undergoing treatment experienced LBP.

In a systematic review, core stability exercise has a large therapeutic effect in patients with chronic LPB include improve core muscle activation and thickness so that reduce pain and functional disability. This-

evidence proposed approach management for chronic LBP should be combination with this core stability exercise beside medication (Frizziero et al., 2021). Research on non-pharmacological methods of LBP therapy has been carried out, but the effect of LBP on diaphragm muscle strengthening exercises using spirometry incentives is still absent. Therefore, the effect of diaphragm muscle training with a spirometry incentive device on LBP still needs to be studied.

The purpose in this research is to find out whether there is an effect of strengthening the diaphragm muscles with a spirometry incentive device on improving pain and core muscle stability in LBP patients.

## 2. MATERIAL AND METHOD

The target population in this study was patients who experienced low back pain. The sampling technique used was non-probability sampling or non-random sampling using purposive sampling techniques.

The instruments used in this study were:

- Form A: Research information sheet
- Form B: Informed consent form as a research subject
- Form C: Research subject data sheet
- Form D: Table of measurements of pain improvement and core muscle stability
- Form E: Research observation sheet

Procedures and if relevant, the time frame:

- 1) Before the diaphragm muscle strengthening exercise, the researcher carried out a pain scale

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measurement test using the NRS questionnaire and measured the stability of the core muscles

- 2) On the NRS questionnaire, respondents are instructed to identify one number between 0 and 10, which best represents the intensity of their pain.
- 3) When measuring core muscle stability, place the tool in the back waist area. Pump the device to 60 mmHg and lock it, while the patient inhales. Then ask the patient to exhale and see the increase in the number on the tool. Note the increase in numbers occurs.
- 4) Diaphragm muscle strengthening exercises are carried out three times a week for one month. One set consists of ten maximal inspirations and rest. Then, continue the exercise to the next set for a total of thirty diaphragmatic breaths.
- 5) After the diaphragm muscle strengthening exercise, the researchers again carried out a test measuring the pain scale using the NRS questionnaire and measuring core muscle stability.

This research procedure used a pre-experimental one group pretest-posttest design. Statistical test in this research use wilcoxon and paired t-test

This research is the first research conducted to look at the effect of diaphragm muscle strengthening

exercises using an incentive spirometry device on improving pain and core muscle stability in patients with LBP.

A limitation in this study is that the tool used to measure core muscle stability, namely the sphygmomanometer, is a reliable tool for assessing core muscle strength but has not been validated for measuring core muscle stability. Exercise is monitored via device and research subject still consumed anti-pain medication such as paracetamol and modality therapy in medical rehabilitation.

### 3. RESULT AND DISCUSSION

#### 3.1 Results

##### 1. Characteristic of research subjects

The characteristic results in this study show that the majority of research subjects were female, with an average age of 47 years and mean body mass index is 23.93. The most achieved inhalation capacity in incentive spirometry in patients during the pre-test was 600 cc/sec (1 ball) and during the pre-test around 900 cc/sec (2 balls).

**Table 1.** Characteristic Subject of Research

Characteristics		Frequency		Mean
		N	%	
Age				47.40
Body Mass Index				23.93
Gender	Woman	16	80	
	Man	4	20	
Inhalation Capacity Pre test	There is no ball raise	4	20	
	600 cc/sec (1 ball)	14	70	
	900 cc/sec (2 balls)	0	0	
	1200 cc/sec (3 balls)	2	10	
Inhalation Capacity Post test	There is no ball raise	0	0	
	600 cc/sec (1 ball)	3	15	
	900 cc/sec (2 balls)	13	65	
	1200 cc/sec (3 balls)	4	20	
Employment	Housewife	9	45	
	Marketeer	2	10	
	Farmer	2	10	
	Midwife	1	5	
	Football Coach	1	5	
	Civil Servant	2	10	
	Cake baker	1	5	
	Retired	1	5	
	Construction workers	1	5	

2. NRS (Numerical Rating Scale) pain before and after incentive spirometry training

The level of LBP in the research subjects before and after doing diaphragm muscle strengthening exercises using the incentive spirometry device was as follows:

**Table 2.** Effect of LBP Pain Levels Before and After Exercise

Pain Level	Pre-test	Post-test
No Pain	0 (0%)	0 (0%)
Mild Pain	2 (10%)	17 (85%)
Moderate Pain	7 (35%)	3 (15%)
Severe Pain	11 (55%)	0 (0%)
Total	20	20

Based on the table 2 above, it shows that the majority of research subjects before exercise experienced severe levels of pain, namely 11 people (55%) and the majority of research subjects after exercise experienced mild levels of pain, namely 17 people (85%).

### 3. Core Muscle Stability in Low Back Pain Patients

Core muscle stability is measured using a sphygmomanometer by looking at changes in pressure in the patient when the patient inhales. When the patient exhales, the numbers on the sphygmomanometer will change. Based on table 3, core muscle strength of subjects before exercise were dominantly on lower strength (55 %) but core muscle strength of subject after exercise were dominantly on normal strength (100 %).

**Table 3.** Effect of Core Muscle Strength Levels Before and After Exercise

Core Muscle Strength	Pre-test	Post-test
Low Strength (<80 mmhg)	11 (55%)	0 (0%)
Normal Strength ( $\geq$ 80 mmhg)	8 (54%)	20 (100%)
Total	20	20

### 4. Data Analysis of Pain Levels and Core Muscle Stability Before and After Incentive Spirometry Exercises

Pain levels decreased and core muscle stability values increased after strengthening the diaphragm muscles

using incentive spirometry. The results of the Wilcoxon test and paired t test obtained a value of less than 0.05, indicating that there was an effect of diaphragm muscle strengthening exercises using incentive spirometry on improving pain and core muscle stability in patients with lower back pain.

**Table 4.** Pain Level and Core Muscle Stability Before and After Diaphragm Strengthening Exercises with Incentive Spirometry

Variable	Frequency	Pre-test	Post-test	P value
Pain Level	20	6.20 (3-8)	2.80 (1-4)	0,000*
Core muscle stability	20	77.29 $\pm$ 3.888	83.85 $\pm$ 2.455	0,000**

\*Wilcoxon test

\*\*Paired t test

### 5. Research Subject Intolerance

This research shows that the majority of patients did not experience complaints during exercise, but 3 patients experienced chest tightness when using the incentive spirometry device by taking excessive breaths. In this research there were also two samples who dropped out due to coughing.

## 3.2 Discussion

### 1. Characteristics of Research Subjects

In research conducted on LBP patients, there were more female respondents than male respondents. The

number of research subjects was around 16 women (80%) and 4 men (20%). In the research conducted (Bento et al., 2020), the prevalence of LBP was higher in women (60.9%) than men (39.1%). Women generally have more responsibilities at home and at work and spend more time doing household tasks than men, they are more likely to be exposed to several risk factors such as inadequate static posture.

The age limit taken in this study was in the range of 25-60 years. The youngest research subject was 26 years old and the oldest 60 years old. There was 1 person under 30 years of age and 19 people over 30 years of age. Although the prevalence of LBP

increases with age up to the age of 80-89 years, the largest number of LBP sufferers globally is currently in the 50-54 years age group. The increase in the overall burden of LBP is likely driven by aging and an increasing population, but there may be other contributing factors (Williamson & Cameron, 2021).

Housewives are the most common occupation among research subjects (9 patients). Research conducted by (Norouzi et al., 2023) has provided evidence of various factors that can contribute to the development of musculoskeletal disorders in housewives. These include: ignorance about the causes of musculoskeletal pain and low self-ability, lack of awareness and social support for housewives, and lack of environmental facilities.

## 2. Pain levels before and after doing diaphragm muscle strengthening exercises with incentive spirometry

Subjects in the study felt pain before incentive spirometry training with a mean of 6.20 (moderate-severe category) and pain after training with incentive spirometry decreased with a mean of 2.80 (mild pain). This is in line with research conducted by (Vicente-Campos et al., 2021) who conducted research on hypo pressive abdominal gymnastics (HAG) which had an effect on inspiratory muscle strength, namely the diaphragm experienced a decrease in pain intensity after exercise.

These results are also strengthened by research conducted by (Otadi et al., 2021) which combines diaphragm exercises and electrical stimulation in athletes with chronic low back pain. This study showed a greater reduction in pain scores in the experimental group who received diaphragm training plus TENS (Transcutaneous Electrical Nerves Stimulation) than in the control group who received TENS alone.

## 3. Level of core muscle stability before and after diaphragm muscle strengthening exercises with incentive spirometry

The average core muscle stability increased before training was 77.29 mmHg and after training it increased to 83.85 mmHg. This is in line with the research conducted (Khusnun et al., 2023) showed the results that providing core stability exercise can reduce pain and increase functional activity in cases of non-specific LBP. This research show similar with previous systematic review research that shown core stability exercise has more efficacy than no other therapeutic combination with this exercise on chronic LBP (Frizziero et al., 2021).

## 4. The effect of diaphragm muscle strengthening exercises with incentive spirometry on LBP

The research showed that there was a significant effect between diaphragm muscle strengthening exercises using an incentive spirometry device on LBP. The results of the study found that after doing incentive spirometry exercises there was a decrease in the level of LBP and an increase in core muscle strength compared to before doing the exercise. Other research showed a decrease in diaphragm thickness and a lower diaphragm thickening capacity in tidal volume and force volume on subjects with non-specific LBP compared to healthy subjects (Perez et al., 2023).

The diaphragm is the main muscle of active inspiration. Impaired function of the diaphragm causes shortness of breath and the work of breathing becomes inefficient. In addition to its respiratory function, the diaphragm is also an important functional unit for dynamic stabilization of the spine during balance tasks and lifting weights. Previous research has shown that individuals with LBP and sacroiliac joint pain exhibit postural control deficits and abnormal diaphragm movement during breathing while performing tasks (Ziaefar et al., 2022).

Respiratory muscle training improves muscle capacity, proprioception, diaphragm, lower back muscles, deep core muscles, and respiratory muscle strength. Previous research has shown breathing exercise improve spinal and chest mobility on healthy young female (Csepregi et al., 2022). Inspiratory muscle training as rehabilitation for LBP patient has been significantly increase multifidus and transverse abdominal muscle activity on core muscle (Ahmadnezhad et al., 2020). Other research founded effectively improvement of core muscle recruitment pattern after core muscle exercise for people with recurrent LBP (Suehiro et al., 2021). On athlete with LBP, respiratory muscle exercise reduces excessive ankle joint activity which indicate improved postural stability on core muscle area (Borujeni & Yalfani, 2019). Based on previous research, it is possible that the effect of diaphragm muscle strengthening exercises using incentive spirometry can help strengthen the diaphragm, which is one part of the core muscles that maintains spinal stability.

## 5. Intolerance of research subjects during an exercise program

Most of the research subjects did not experience significant complaints when carrying out incentive spirometry exercises. Three research subjects experienced chest tightness during exercise and after exercise. One research subject's complaints disappeared when he reduced the breathing load on the incentive spirometry device from 3 balls to just 1 ball. Two other patients experienced mild chest

tightness after exercise and it improved after a few minutes. The complaints experienced by the two patients did not continue, it is possible that the body adapted to the exercises carried out. In this study, four research subjects dropped out. Two patients had a cough that did not go away and two other patients did not exercise according to the research requirements. There were two subjects who experienced coughs that did not heal during the research process and were excluded.

The research results can become an additional therapy option for LBP patients and become the basis for developing further research related to non-pharmacological therapy for LBP. On the other side this exercise hopefully can reduce deterioration, increase independence and quality of life for patients.

The limitation in this study is related the tool used to measure core muscle stability, sphygmomanometer. For long time this device is a reliable tool for assessing core muscle strength but has not been validated for measuring core muscle stability. Exercise was only monitored via device and the respondents are still taking pain reliefer such as paracetamol and therapy in medical rehabilitation, so it can conducted bias on the data.


We suggest for future researchers should be to carry out direct monitoring when carrying out diaphragm muscle strengthening exercises using incentive spirometry. Tools for measuring core muscle stability for future research should have better sensitivity and specificity. Future research should use a volume-oriented incentive spirometry tool which is better at strengthening the diaphragm muscles and use a control group in the research

#### 4. CONCLUSION


Diaphragm muscle strengthening exercises using incentive spirometry have an effect on improving pain and increasing core muscle stability in patients with LBP.


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